



TITLE:

# Surgical Treatment of Diverticula of the Mid-thoracic Esophagus, with Special References to Their Pathogenesis

AUTHOR(S):

ISHIGAMI, KOICHI; MATSUO, YUTAKA; YAMANE, MAMORU; SUZUKI, HIROSHI

---

CITATION:

ISHIGAMI, KOICHI ...[et al]. Surgical Treatment of Diverticula of the Mid-thoracic Esophagus, with Special References to Their Pathogenesis. 日本外科宝函 1965, 34(2): 509-523

ISSUE DATE:

1965-03-01

URL:

<http://hdl.handle.net/2433/206459>

RIGHT:

## 臨 床

# Surgical Treatment of Diverticula of the Mid-thoracic Esophagus, with Special References to Their Pathogenesis

by

KOICHI ISHIGAMI, YUTAKA MATSUI, MAMORU YAMANE  
& HIROSHI SUZUKI

From the 2nd Surgical Division, Kyoto University Medical School  
(Director : Prof. Dr. CHUJI KIMURA)

Received for Publication Jan. 18, 1965

### Introduction

Diverticula of the esophagus have been usually classified into three well-established types : pharyngoesophageal and epiphrenic pulsion diverticula and parabronchial traction diverticula. We have encountered seven cases of diverticula of thoracic esophagus for these one and a half years. After investigating the operative and histological findings in these cases, we confirmed the possibility that some cases of mid-thoracic esophageal diverticula may arise on a congenital basis.

### Case reports

**Case 1**, Y. I., a 71-year-old man.

Admitted June 18, 1963.

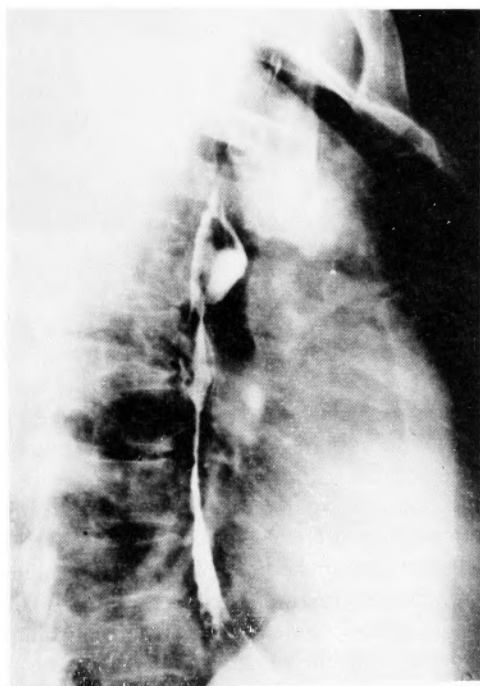
Chief complaint : Food sticking in his sub-sternal region.

Past history : He was suffering from pulmonary tuberculosis at the age of 35.

Present history : He had complained of post-prandial retrosternal distress and belching of about two months' duration.

Roentgenogram of the chest revealed several calcifications in the left hilar region and a tent-like elevation on the thoracic surface of the right diaphragm. The roentgen examination with barium swallow revealed a triangular diverticulum, measuring 1.5 by 4.0 cm in its greatest diameter and arising from the anterior wall of the esophagus at the level of Th<sub>4-5</sub> (Photo 1).

Operation (June 25, 1963) · Under intratracheal GOF intubationsanesthesia, a standard thoracotomy incision was made through the fifth intercostal space on the right side. Diverticulum arose from the anterior wall of the mid-thoracic esophagus behind the carina and apparently had coats similar to the normal esophagus. Its apex



**Photo 1** Esophagogram of case 1.  
Right anterior oblique projection.

was buried in the mass of swollen bifurcal lymph nodes which were adherent to each other, but no adhesion or communication between the diverticulum and the tracheobronchial tree was observed.

Histological examination of incised diverticulum revealed only the mild anthracosis of the bifurcal lymph node, but no tuberculous lesion. The inflammatory change was scarcely present in the wall of diverticulum.

Postoperative course was uneventful. He was discharged from the hospital in a very satisfactory state on July 23, 1963.

This case is a typical case of traction diverticula, as described by ROKITANSKY and KRAGH.

**Case 2, Y. Y., a 29-year-old woman.** The first medical examination : June 11, 1964.

Chief complaint : Epigastric fullness.

Present history : She had been complaining of epigastric fullness for two or three years prior to admission and recently also of mild heartburn.

The roentgen examination with barium swallow revealed a saccular diverticulum, measuring 3.2 by 2.6 cm in its greatest diameter, arising from the right anterior wall of the esophagus at the level of Th<sub>11</sub> about 2.4 cm above the diaphragm and bulging to the caudal, with the base opening of 1.3 cm in breadth. No peristalsis was observed at the diverticulum and the diverticulum had emptied itself of its contents unsatisfactorily in the erect posture. Definite narrowing couldn't be demonstrated below the level of the diverticulum (Photo 2).

This case is a typical case of epiphrenic pulsion diverticula, although it is not yet operated upon.

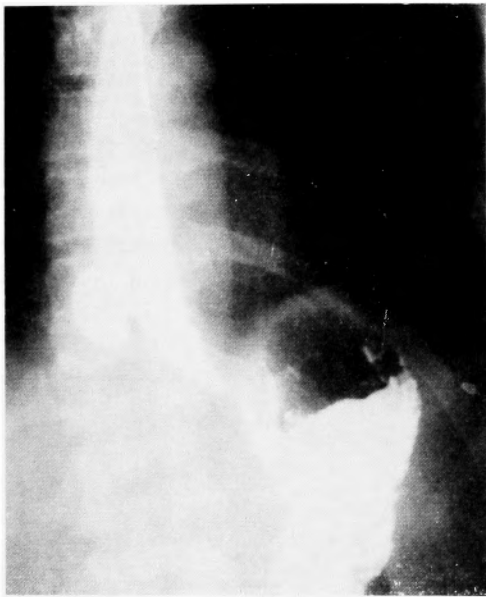
**Case 3, C. K., a 62-year-old woman.**

Admitted November 9, 1963.

Chief complaint : Food sticking in deglutition.

Present history : Seven months prior to admission she had a feeling of food sticking in her throat of about ten days' duration after rapid swallowing. One month previously, she had a feeling of food sticking behind the xiphoid process after swallowing of a rice-cake and vomited the ingested food particles.

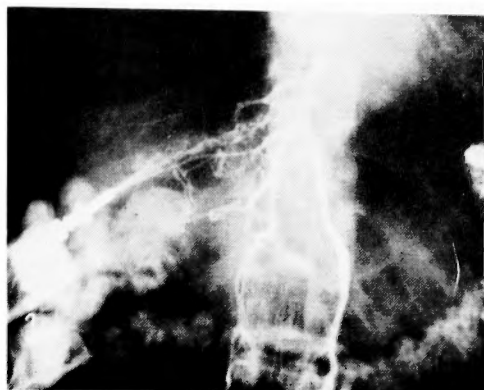
The roentgen examination with barium swallow showed the presence of a saccular or globular diverticulum, measuring 2.1 by 2.6 cm in its greatest diameter, arising from the anterior wall of the esophagus at the level of Th<sub>6-7</sub>, and projecting to the right, whose wall showed a considerable degree of peristalsis. The esophagus was a little dilated above the diverticulum and deviated to the left posterior at the level of the diverticulum (Photo 3). In the azygogram, the anteroposterior projection showed the incomplete filling of the radioopaque media above the upper margin of the eighth thoracic vertebral body, the reflux into the azygos vein toward the level of L<sub>2</sub> and into the 9th and 11th intercostal veins and the cross-over into the hemiazygos vein (Photo 4). The lateral projection showed the stenosis of the azygos vein from the upper margin of Th<sub>7</sub> to the level of Th<sub>6</sub> and the unevenness on its posterior wall at the level of Th<sub>5</sub>. Bronchogram showed a fold-like dent on the posterior wall of the right main bronchus.



**Photo 2** Esophagogram of case 2.  
Anteroposterior projection.



**Photo 3** Esophagogram of case 3.  
Left anterior oblique projection.



**Photo 4** Azygogram of case 3.

Operation (November 20, 1963) : Under intratracheal GOF intubationsanesthesia, a standard thoracotomy incision was made through the sixth intercostal space on the right side. The right lung was rather densely adherent to the parietal pleura and to the diaphragm. The diverticulum was found about 2 cm below the carina and projected anteriorly and to the right. Its overlying pleura was vigorously thickened and cicatricial. The apex of the diverticulum extended to the posterior wall of the right main bronchus about 2.5 cm distal from the carina with a fibrous cord (Photo 5). There was no surrounding swollen lymph node or adhesion adjacent to the apex of the diverticulum. The diverticulum was carefully dissected and removed in a typical manner, as mentioned below. The outer muscular layer of the diverticulum was very thin, but its inner muscular layer existed in the normal thickness. A pinhead-large dent was observed on the mucosal surface of the apex of the diverticulum. Microscopically, the wall of the diverticulum quite lacks in the findings of inflammation.

Postoperative course was uneventful. She started to take solid food on the 13th postoperative day and had no trouble in swallowing. Barium examination of the esophagus showed



**Photo 5** Operative findings of case 3.

The apex of the diverticulum extended to the posterior wall of the right main bronchus with a fibrous cord. NÉLATON's catheters were looped around the esophagus above and below the level of the diverticulum.

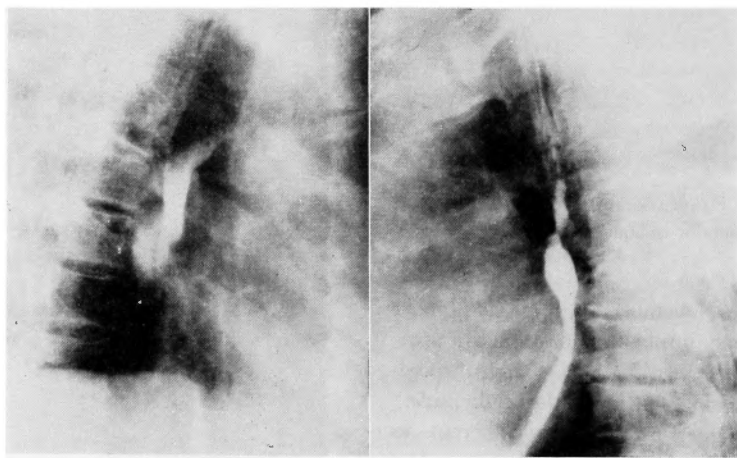
the complete disappearance of the diverticulum. She was discharged from the hospital on December 18, 1963.

**Case 4, K. Y.,** a 47-year-old man. Admitted December 3, 1963.

Chief complaint : Retrosternal food sticking in deglutition.

Present history : One week prior to admission he complained of food sticking, distress and dull pain in the retrosternal region in deglutition. Thereafter, he complained of the slight degree of food sticking of 3 days' duration.

Roentgenogram of the chest showed several rice-grain-large calcifications in the left hilar region. The roentgen examination with barium swallow revealed a triangular diverticulum, measuring 2.2 by 4.0 cm in its greatest diameter and arising from the anterior wall of the esophagus.



**Photo 6** Esophagogram of case 4. Left and right anterior oblique projection.

The longitudinal axis of the distal segment of the esophagus showed some deviation in the direction toward the left posterior from that of the proximal segment at the level of the diverticulum (Photo 6).

Operation (December 11, 1963) : Under intratracheal GOEF intubationsanesthesia, a standard thoracotomy incision was made through the fifth intercostal space on the right side. The right lung was rather densely adherent to the parietal pleura. A diverticulum, measuring about 3 by 3 cm in its greatest diameter, was found about 3 cm below the carina. Its apex extended to the posterior wall of the left main bronchus with a fibrous cord. However, no fistulous communication was found between the diverticulum and the bronchus. There were no surrounding swollen or cicatricially scarring lymph nodes adjacent to the diverticulum. The junction of the diverticulum with the bronchus was ligated and divided near to the former and the diverticulum was removed in a typical manner.

Histological specimens of the diverticulum revealed a slight hyperplasia of squamous cell epithelium, fibrosis of submucosal and mucosal coats and the appearance of a mild chronic diverticulitis, such as the infiltration of lymphocytes and polynuclear leucocytes.

Postoperative course was uneventful and barium examination of the esophagus showed it to be normal. He was discharged from the hospital in a very satisfactory state on January 21, 1964.

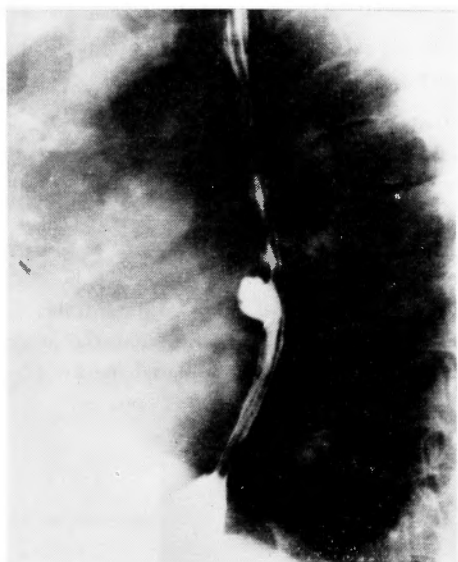
**Case 5, T. K.,** a 62-year-old woman. The first medical examination : March 11, 1964.

Chief complaint : Retrosternal food sticking in deglutition.

Present history : One month prior to admission he experienced increasingly severe food sticking in the retrosternal region.

The roentgen examination with barium swallow revealed a saccular diverticulum, measuring 1.6 by 2.0 cm and arising from the right anterior wall of the esophagus at the level of Th<sub>7</sub>. The entrance to the diverticulum was fairly large. The diverticulum showed the brisk peristalsis in its wall and had easily emptied itself of its contents and didn't retain barium, unless the examination with fairly thick paste was performed in the left anterior oblique projection and in the recumbent position (Photo 7).

This case is not yet operated upon.



**Photo 7** Esophagogram of case 5.  
Left anterior oblique projection.



**Photo 8** Esophagogram of case 6.  
Left anterior oblique projection.

**Case 6**, S. T., a 47-year-old woman. Admitted January 25, 1963.

Chief complaint : Retrosternal food sticking in deglutition.

Present history : Three months prior to admission she experienced retrosternal food sticking and distress of one hour's duration one or two hours after supper. She had similar bouts every two or three days and complained also of belching after she took a fatty meal. These distresses didn't vary in their degree with the changing of posture and the solidity of food.

The chest showed the pigeon-breast and a few moist râles or friction rubs were audible at the left anterior lower breast. ECG revealed the sinus arrhythmia. Roentgenogram of the chest showed few small calcifications, irregular in shape, in the right middle or lower and the left middle pulmonary fields. The roentgen examination with barium swallow revealed an elliptical diverticulum with sharp borders, measuring 3.4 by 2.0 cm in its greatest diameter and arising from the right anterior wall of the esophagus 6 cm above the diaphragm. At times, it produced a horizontal fluid surmounted by air and emptied itself of its contents in the left lateral position. The peristaltic activity at the wall of the diverticulum was preserved normally and there was a little dilatation of the esophagus above the diverticulum (Photo 8).

Operation (February 1, 1963) : Under intratracheal GOF intubationsanesthesia, a standard

thoracotomy incision was made through the sixth intercostal space on the right side. A diverticulum, measuring about 3.5 by 2 cm, bulged from the right anterior wall of the esophagus. No firm adhesion was observed between the diverticulum and the overlying mediastinal pleura. The diverticulum was removed in a typical manner and the repaired defects were reinforced with a rectangular pedicle flap from the parietal pleura.

The extirpated diverticulum had coats similar to the normal esophagus and its muscular layer was about 2 or 3 mm in thickness in its gross appearance. Histologically, the wall of the diverticulum had coats similar to the normal esophagus and was devoid of the inflammatory findings.

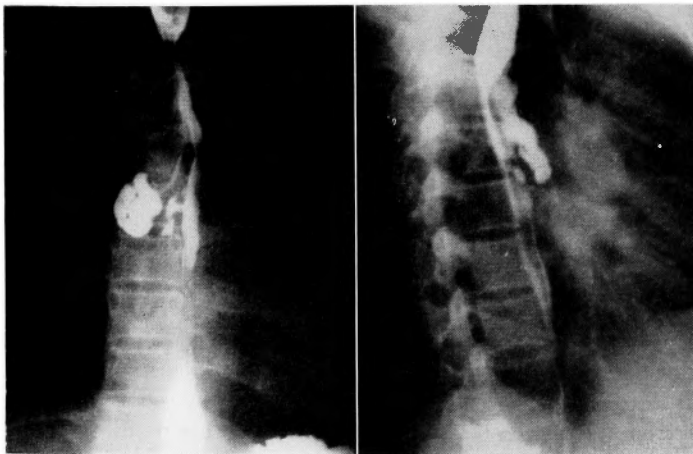
Postoperative course was almost uneventful. She began to take pure rice-gruel on the 15th postoperative day. On the 17th postoperative day, she complained of postprandial dull pain, a feeling of food sticking in the epigastric region and sour belching. Barium examination of the esophagus, on the 19th postoperative day, showed it to be normal. After the administration of ACL, a drug for the prevention and the treatment of reflux esophagitis, these distresses gradually diminished. She was discharged from the hospital on February 26, 1963.

**Case 7, F. N.,** a 35-year-old woman. Admitted April 9, 1964.

Chief complaint : Retrosternal food sticking in deglutition.

Present history : Two and a half months prior to admission she experienced a feeling of food sticking in the retrosternal region and 20 days before admission she had retrosternal pain in deglutition of three days' duration.

The roentgen examination of the esophagus revealed a diverticulum, measuring 5.1 by 2.0 cm and arising from the right anterior wall of the esophagus at the level of  $Th_{6-6}$ . Its entrance into the esophagus was tubular in shape, while its apex was elliptical and suspended from the anterior wall of the esophagus to the right anterior. The esophagus was slightly displaced backward by the compression of the diverticulum and slightly dilated above the diverticulum (Photo 9).



**Photo 9** Esophagogram of case 7.  
Anteroposterior and right anterior oblique projection.

(Operation (April 19, 1964) : Under intratracheal GOF intubationsanesthesia, a standard thoracotomy incision was made through the fifth intercostal space on the right side. A diverticulum, measuring 5 by 1 cm, bulged from the right anterior wall of the esophagus at the level of the carina, pointing to the right antero-caudal. Its surface was covered by the mediastinal pleura and a areolar fibrous capsule. The wall of the diverticulum had coats similar to the normal esophagus and was thickened. The esophagus and the diverticulum had the common muscular

layer. The neck of the diverticulum was about 1 cm in breadth and its apex didn't communicate with the tracheobronchial tree. The diverticulum was removed in a typical manner and the defects of the esophageal wall were closed in layers and further reinforced with the LEMBERT's interrupted sutures.

Histological examination of the excised diverticulum revealed the coexistence of squamous cell epithelium and gastric glandular epithelium in the mucosal layer, and the aberrant pancreatic tissue, especially LANGERHANS islet cells scattered in the submucosal and muscular layers (Photo 10).

Postoperative course was uneventful. Barium examination of the esophagus, on the 19th postoperative day, showed it to be normal. She was discharged from the hospital in a very satisfactory state on May 13, 1964.

### Discussion

Diverticula of the esophagus have been usually classified into three well-established types: pharyngoesophageal and epiphrenic pulsion diverticula and parabronchial traction diverticula. The incidence of these types are shown in Table 1.<sup>21) 27) 30)</sup> Diverticula of

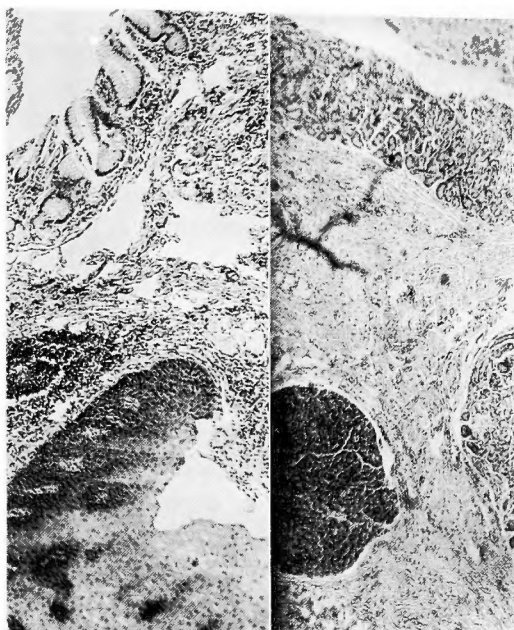


Photo 10 Histological findings of case 7.

Table 1 Frequency of occurrence of diverticula of the alimentary tract.

Site of diverticula		Author	Postlethwait, R.W. & W.C. Sealy (1961)		Terracol, J. & R. H. Sweet (1958)		Wheeler, O. (1947) Total 2000 cases	
Esophageal diverticula	Pharyngo-esophageal		994	62.4%	94	79.7% <sup>1</sup>	22	0.11%
	Parabronchial		436	27.4%	9	7.6%	6	0.03%
	Epiphrenic		163	10.2%	15	12.7%	3	0.015%
	Total		1593		118		31	0.155%
Gastric diverticula							20	0.1%
Duodenal diverticula							102	5.1%

the esophagus, especially of the mid-thoracic esophagus, are more infrequent, as compared with duodenal diverticula. Parabronchial diverticula are usually of the traction type, and conical in shape, with the base opening into the anterior wall of the esophagus. Their necks are wide and the apexes usually point either horizontally or slightly upward, so that emptying occurs easily. Therefore, these diverticula are usually asymptomatic and show at times only minor symptoms, so far as no complication has developed, and usually no treatment is required.

Generally speaking, diverticula of the esophagus may arise either as a result of weak-



ness or defect in the muscular wall, or as a result of the pull of contracting scar tissue within the mediastinum, in association with the elevation of intraesophageal pressure above a point of stricture.

In 1840 ROKITANSKY first described the mode of formation of the traction diverticula of the esophagus. In 1878 ZENKER and VON ZIEMSEN found a firm scar tissue area directly against the apex of the diverticulum. This was firmly adherent to the diverticulum, in some instances surrounding the diverticulum and in others extending to it with radiating prolongations or bands. In the majority of their cases, firm shrunken bronchial lymph nodes not infrequently enclosing calcium deposits could be found in the periphery of the diverticulum. KRAGH<sup>15)</sup> divided his cases of traction diverticula, in which the nodes were tuberculous, into acute and chronic groups. In the acute, the process varies from a slight infiltration of round cells to a necrotizing process. In several of the chronic cases, a proliferation of the epithelium of the esophagus through the perforation toward the node was seen. He then examined 51 traction diverticula by serial sections and in nearly all the cases adherence to lymph nodes affected by fresh or old tuberculosis was found. Namely, in a small number of acquired traction diverticula, as shown by KRAGH and KAUFMAN, the affection in the tuberculous lymph nodes proceeds acutely, an actual perforation of the esophagus may take place and the resulting abscess cavity as it heals is lined by esophageal epithelium and the diverticulum results. However, in a large number of these diverticula, the esophagus is fixed to the mass of tuberculous lymph nodes by cicatricial adhesions, loses its mobility and little by little, as a result of the movement produced by deglutition, by respiration, or by bouts of coughing, its wall becomes stretched out and distended to produce a diverticulum. Therefore, although some of the traction diverticula may lack in the muscular layers in their walls, most of them will contain all the layers of the esophagus. Sometimes, there will be the cicatricial lesions or the tuberculous ulcer in the apex of the diverticulum. At times, the diverticulum is more or less buried in the mass of lymph nodes, whereas in others the nodes have apparently healed to a considerable extent or regressed in size. These diverticula are most frequently below the carina and in most cases to the right of the midline because the esophagus is in most intimate contact with nodes which lie just below the right main bronchus above the carina. However, the esophagus is nearest to nodes on the left side so that in those few cases in which the diverticulum is above the carina it is more likely to project to the left. Although tuberculous lymph nodes are the universal cause of these diverticula, simple pyogenic lymphadenitis, actinomycosis, anthracosis etc. may give rise to these diverticula. These diverticula may also be secondary to periesophageal abscesses, pericarditis, pleurisy, perichondritis of cricoid cartilages, thyreoiditis and caries of spine. A small number of traction diverticula lack in the muscular layer in their walls, so that the constant pressure of the food upon a weak portion may give rise to a traction-pulsion diverticula at the rate of 8~10 per cent of the total<sup>31)</sup>. On the other hand, a fistulous communication between an esophageal traction diverticulum and the tracheobronchial tree may occur when the periesophageal abscess arising from the mid-thoracic traction diverticula or tuberculous lymph nodes burst into the esophagus and the tracheobronchial tree. In an analysis of 93 reported cases of acquired non-malignant esophagorespiratory fistula by COLEMAN<sup>7)</sup>, eso-

phageal diverticula were responsible for fistula formation in 14 cases. In 4 cases the esophagus communicated with a main bronchus and in 8 cases with a secondary bronchus.

In the cases of the parabronchial diverticula, as seen in cases 3 and 4, no lymph node involvement or no inflammatory adhesion surrounding the diverticulum could be found, even though the evidence of mild diverticulitis might be observed. Therefore, these diverticula lack in the characteristic pathological findings of traction diverticula by KRAGH and the possibility that these diverticula arise on a congenital basis has been considered.

Embryologically, the foregut corresponds to the alimentary tract situated more oral from the papilla of VATER and such organs, as pharynx, esophagus, stomach, larynx, trachea, bronchi, lungs etc., develop from the foregut. Until the third week of embryonic life both the esophagus and the trachea form one tube. From the fourth week to the twelfth week of embryonic life a reduplication of the foregut is brought about to form two tubes. The dorsal tube becomes the esophagus and the ventral becomes the respiratory tract. INGALLS and PRINDLE<sup>12)</sup> concluded that the esophageal atresia, tracheoesophageal fistula and certain commonly associated defects represent departures from normal development at about the fifth or sixth week of embryonic life caused by agents acting through the mother and placenta. Various classifications of esophageal atresia with or without esophago-tracheal or -bronchial fistula have been proposed by VOGT<sup>28)</sup>, LADD, GROSS<sup>8)</sup> etc.<sup>10)</sup> The incidence of esophago-tracheal or -bronchial fistula without esophageal atresia, that is, VOGT's type 4, GROSS group E and F or so-called H-type of fistula, have been encountered in two cases (2~3%) among 63 cases reported by HAIGHT<sup>9)</sup>, in 27 cases (2.5%) among 1068 cases reviewed by POSTLETHWAIT and SEALY<sup>24)</sup> and in four cases (1.8%) among 218 cases reported by WATERSTON<sup>29)</sup>. The possibility that the parabronchial diverticulum may arise on a congenital basis, such as an abortive form of esophago-tracheal or -bronchial fistula without esophageal atresia, have been proposed for the first time by RIBBERT in 1902.<sup>25)</sup> ROBB reported the successful excision of a thoracic diverticulum in an 11-year-old boy, the lesion being located about 1cm above the carina, and in close association with a tracheal fistulous communication to the opposite wall of the esophagus<sup>21)</sup>. BIFANI<sup>3)</sup> reported the case of a 31-year-old white woman who experienced increasingly severe dysphagia and precordial pain of four years duration. A barium swallow revealed a small diverticulum 1 by 2cm at the level of the tracheal bifurcation. During exploration a short fibrous cord between the diverticulum and the first centimeter of the left main bronchus was found. SCHMUCK<sup>26)</sup> also reported the case of a 50-year-old male patient who complained of increasingly severe retrosternal distress, dysphagia, sour belching and vomiting for three years prior to admission. Roentgen examination with barium swallow revealed a conical traction diverticulum at the level of the carina. At the time of operation, a pencil-wide fibrous cord between the apex of the diverticulum and the first portion of the right main bronchus was found, but no lymph node involvement was found. On the other hand, ASADA<sup>1)</sup> reported the case of a 34-year-old woman in whom both an esophageal diverticulum, the size of a little finger tip, at the level of the carina and a gastric diverticulum, the size of a thumb tip, on the posterior wall of the proximal cardia concurrently. In our cases 3 and 4, the apex of the diverticulum extended to the posterior wall of a main bronchus with a fibrous cord. Moreover, the longitudinal axis of

the distal segment showed some deviation from that of the proximal segment at the level of the diverticulum.

From the above-mentioned evidences, it is thought to be logical that the parabronchial esophageal diverticula may arise from an abortive form of esophago-tracheal or -bronchial

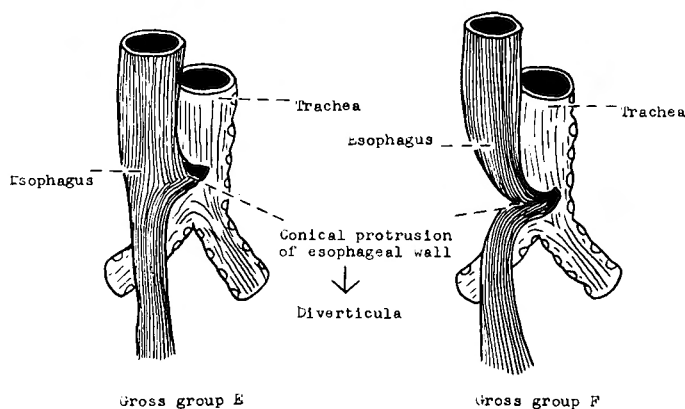


Fig. 1 Esophageal diverticula arising from an abortive form of esophago-tracheal or -bronchial fistula without esophageal atresia.

fistula of GROSS group E or F, in which a blind pouch or an area of regional weakness of muscular layers is brought about when a reduplication of the foregut occurs at the fifth or sixth week of embryonic life. This possible developmental mechanism of parabronchial diverticula is quite similar to that of MECKEL's diverticula due to the incomplete obliteration of vitelline duct (Fig. 1).

Some authors reported that neurenteric strands may give rise to traction diverticula which may be combined with the vertebral body cleft, such as spina bifida<sup>18)</sup>.

In view of the suggested genesis of the tracheal or bronchial diverticula, usually three types have been classified: the supernumerary buds, the pulsion and traction diverticula. If the above-mentioned type of congenital esophageal diverticula is present, the tracheal or bronchial diverticula may arise on a similar congenital basis. OGURA et al.<sup>22)</sup> reported the case of a 37-year-old woman suffering from a blind saccular diverticulum situated on the medial side of the posterior wall of right main bronchus at the level approximately 2 cm distal from the carina. KACHI et al.<sup>13)</sup> reported the case of a 55-year-old man suffering from a tracheal diverticulum, the size of a hen's egg, at the margin of membranous portion on the right lateral wall of trachea a little above the carina. It is worthy to note that these diverticula arise from the posterior wall of trachea or main bronchus adjacent to the carina. YAMASAKI<sup>33)</sup> noted the rarity of tracheal atresia as compared with esophageal atresia and called attention to the difference between the thin dorsal layer of cells and the thicker epithelium on the ventral side of the primitive foregut. He postulated that the rapid growth of the trachea and pulmonary primordium used so much of the "growth potential", as expressed in available cells, that the posterior digestive segment could not be provided with enough cellular material to complete the esophagus. The rarity of con-

genital tracheal or bronchial diverticula as compared with esophageal diverticula is thought to be due to the similar reason.

These esophageal diverticula are frequently conical in shape and their fluoroscopic shadows move together with the action of deglutition, as seen in ROKITANSKY's traction diverticula. However, in the ROKITANSKY's diverticula, the contour of roentgen image is often irregular, and the calcified lymph nodes may be sometimes demonstrated in this region, and they are frequently associated with the middle lobe syndrome, as shown by KATZ<sup>14)</sup> and KUNIGOSHI<sup>15)</sup>.

It is necessary to presume another congenital basis with respect to the developmental mechanism of thoracic esophageal diverticula, as seen in cases 5, 6 and 7, in which the diverticula or their apexes locate at the level a little caudal from the carina and far above the diaphragm, and which are composed of all layers of esophageal wall. Usually, the wall of epiphrenic diverticulum is composed of mucosa, submucosa, muscularis mucosa and an outer fibrous layer of varying density. They have only scattered or no muscle fibers in the walls.

Double esophagus or reduplication of the esophagus is the cyst in the posterior mediastinum situated along the normal esophagus, in which the second lumen is lined by the same epithelium as the normal esophagus and its lower end communicates usually with the main lumen. The walls of the second segment contain all layers of the normal esophagus, but its lumen may be lined by the epithelium of the stomach or the small intestine. Sometimes, these two lumens may have the common outer muscular layers. As BREMER<sup>5)</sup> postulated that most of these spherical cysts may have close relations to the esophageal diverticula, these findings in the double esophagus quite resemble those in case 7.

In most common types of congenital esophageal atresia with esophago-tracheal or -bronchial fistula (VOGT's type 3 b, LADD's type III, GROSS group C), the upper segment of the esophagus usually ends in a blind pouch high in the posterior mediastinum, at or above the level of the tracheal bifurcation, and the lower segment originates in a fistula from the membranous portions of the trachea, the carina, or one of the primary bronchi. In an unusual variant of this type, in which the proximal segment of the esophagus is of abnormal length ending below the level of the carina, and the longitudinal axis of the distal segment shows some deviation from that of the proximal one, the possibility that the esophageal diverticula may arise from the blind pouch at the distal end of the proximal segment, as an abortive form of the double esophagus, have been considered (Fig. 2). Yahr<sup>32)</sup> reported the case of a Negro female infant with such anomaly who was operated upon 6 hours after a normal full term delivery at the age of one day. POSTLETHWAIT and SEALY<sup>24)</sup> had also reviewed 8 cases of double esophagus which had possible close relations with esophageal diverticula.

It will be observed that in the foregut the primordia of the lung bud, esophagus, stomach and pancreas situate in close proximity to each other and inseparable. The fact that the diverticulum of case 7 had the aberrant gastric and pancreatic tissues in the wall is thought to be due to this reason. And it gives an evidence of possible correlation between the development of mid-thoracic esophageal diverticula and the congenital anomalies. NAKAYAMA<sup>19)</sup> has studied the constitution of the muscular coat of the esophagus and clari-

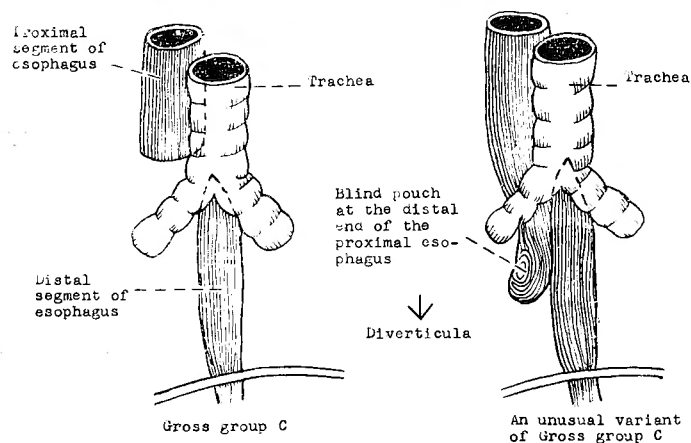


Fig. 2 Esophageal diverticula arising from an abortive form of double esophagus.

fied the following facts: The circular fibers of the esophagus emerge from the 2nd month of embryonic life, while the longitudinal fibers are formed a little later at about the third or fourth month of embryonic life and so forth. It gives reason why the above-mentioned esophageal diverticula show at times poor development of the longitudinal muscular layers in their walls<sup>17) 19)</sup>.

Why should these esophageal diverticula arising possibly on a congenital basis occur in men over the age of 50? Although pharyngoesophageal and epiphrenic pulsion diverticula are thought to arise in the areas of congenital weakness, the former are seen almost exclusively in subjects over 50 years of age at the rate of about 70 % of the total, and uncomplicated epiphrenic diverticula ordinarily do not become symptomatic until the fifth or sixth decade<sup>23) 31)</sup>. The explanation of the late onset of symptoms in these diverticula is that the weakness of the tissue as a manifestation of senescence, incoordination of the muscles participating in the swallowing mechanism, the complication of diverticulitis and the increased interest in esophageal cancer occur more commonly in older people than in the young. Achalasia has been considered a frequently associated factor with the esophageal diverticula. But in our cases, this complication was not observed.

When it is possible, one-stage diverticulectomy is the ideal treatment. Because most of the above-mentioned diverticula locate on the anterior wall of the esophagus and bulge to the right side, the approach may be through the right pleural cavity. If a resection of lower esophagus is to be carried out because of a cicatricial stenosis or the presence of a carcinoma, or if a coexisting hiatus hernia or an achalasia is to be repaired, the left side should be chosen<sup>27)</sup>. At first, the mediastinal pleura overlying the esophagus is incised and the diverticulum and esophagus adjacent to the neck are mobilized. Several small branches of esophageal arteries or veins must be severed. The muscular layer at the neck of the sack is circumcised exposing the mucosal layer of the pouch. The mucosal layer is severed partially from the edge of longitudinal axis of the esophagus. The interrupted through and through mucosal sutures approximate the mucosal layer of the defect using fine silk sutures and the knots are tied within the lumen of the esophagus. At this time,

one suture is tied after the following suture has inserted and made ready to ligate. In this manner, the excision of mucosal layer, insertion and ligature of sutures are going on and the diverticulum is removed. The muscular layers of the esophagus are then closed with fine interrupted silk sutures. Sometimes, the repaired defects are reinforced with an outer layer of LEMBERT sutures, a free pleural flap (DENK), a pedicle flap from the pleural or the prevertebral fascia (BEARDSLEY) etc.. With a wide-caliber rigid nasogastric tube, or when possible, with the MC GILL tube threading over a LEVIN tube, passed through the esophagus beyond the neck of the diverticulum, its dissection, removal and the closure of mucosal layer are to be carried out without encroaching on the lumen of the esophagus itself and the risk of surgical stenosis is lessened. After closure of the mucosal layer, the MC GILL tube is withdrawn to allow for a relaxed closure of the muscular layer<sup>2)</sup>.

### Summary and conclusion

Diverticula of the esophagus have been usually classified into three well-established types : pharyngoesophageal and epiphrenic pulsion diverticula, and parabronchial traction diverticula. We have encountered seven cases of diverticula of thoracic esophagus for these one and a half years. After investigating the operative and histological findings in these cases, we confirmed that the following possibility is thought to be present : The diverticula of mid-thoracic esophagus may arise from an abortive form of esophago-tracheal or -bronchial fistula without esophageal atresia of GROSS group E or F, in which a blind pouch or an area of regional weakness in muscular layers is brought about when a reduplication of the foregut occurs at the fifth or sixth week of embryonic life. They also may arise from an unusual variant of GROSS group C, or from an abortive form of double esophagus, in which the proximal segment of the esophagus is of abnormal length, ending below the level of the carina, and the longitudinal axis of the distal segment shows some deviation from that of the proximal one, and thus the blind pouch is formed at the distal end of the proximal one. We investigated the characters of these esophageal diverticula possibly arising on such congenital basis, and wish to call attention to these new types of esophageal diverticula.

The authors wish to thank Prof. CHUJI KIMURA for his very helpful suggestions and criticisms in regard to the problems discussed here.

The gist of the present article was reported by KOICHI ISHIGAMI before the 17th General Meeting of the Japanese Association for Thoracic Surgery on October 30, 1964.

### REFERENCES

- 1) Asada, K. & Z. Tani : Gastric and oesophageal diverticula discovered in the same person. Report of a case. *Kitano Hospital J. Med.*, **1** : 1,54-58, 1955.
- 2) Beardsley, J. M. : Technique in resection of esophageal diverticulum. *Surgery*, **50** : 5, 747-748, 1961.
- 3) Bifani, I. : Disfagia grave da sindrome discinetica esofagea su diverticolo epibronchiale. *Gior. ital. Chir.*, **13** : 1014, 1957. (*Internat. Abst. Surg.*, **107** : 548, 1958).
- 4) Boyden, E. A. : Presumptive origin of a left lower accessory lung from an esophageal diverticulum. *Surgery*, **52** : 2, 323-329, 1962.
- 5) Bremer, J. L. : Diverticula and duplications of the intestinal tract. *A. M. A. Arch. Path.*, **38** : 3, 132-140, 1944.
- 6) Bungart, H., K. Kremer & A. S. Hammam : Die chirurgische Behandlung der Ösophagusdivertikel. *Zbl. Chir.*, **87** : 18, 769-781, 1962.

- 7) Coleman, F. P. : Acquired non-malignant esophagorespiratory fistula. *Am. J. Surg.*, **93** : 321-328, 1957.
- 8) Gross, R. E. : *Surgery of infancy and childhood*. 1953, W. B. Saunders Co., Philadelphia & London.
- 9) Haight, C. : Congenital tracheoesophageal fistula without esophageal atresia. *J. Thoracic Surg.*, **17** : 5,600-612, 1948.
- 10) Humphreys, G. H. & J. M. Ferrer : Management of esophageal atresia. *Am. J. Surg.*, **107** : 3, 406-411, 1964.
- 11) Inada, K., N. Hayashi & K. Masuda : Esophageal cyst of the mediastinum. *Kyobu Geka*, **12** : 2, 131-135, 1959.
- 12) Ingalls, T. H. & R. A. Prindle : Esophageal atresia with tracheoesophageal fistula. Epidemiologic and teratologic implications. *New England J. Med.*, **240** : 25, 987-995, 1949.
- 13) Kachi, M. et al. : A successfully operated case of tracheal diverticulum. *Kyobu Geka*, **12** : 7, 578-581, 1959.
- 14) Katz, H. L. : Traction diverticula of the esophagus in middle lobe syndrome. *Ann. Rev. Tuberc.*, **65** : 4, 155-161, 1952.
- 15) Kragh, J. : Tuberculous diverticula of the oesophagus (so-called traction diverticula). *Acta oto-laryng.*, **4** : 49-62, 1922.
- 16) Kunigoshi, U. : Supplemental findings of traction oesophageal diverticula. *Kyobu Geka*, **8** : 10, 941-944, 1955.
- 17) Lerche, W. : The muscular coat of the esophagus and its defects. *J. Thoracic Surg.*, **6** : 1, 1-19, 1936.
- 18) Mc Letchie, N. G. B., J. K. Purves & R. L. De C. H. Saunders : The genesis of gastric and certain intestinal diverticula and enterogenous cysts. *Surg. Gynec. & Obst.*, **99** : 2, 135-141, 1954.
- 19) Nakayama, T. : Functional-anatomical studies on the esophagus with special reference to the architecture of the muscle coat. *J. Jap. Bronchoesophagol. Soc.*, **15** : 2, 79-84, 1964.
- 20) Nakayama, T. : *Surgery of the esophagus*. Library of Thoracic Surg., 19, 1955, Nankodo Co., Tokyo & Kyoto, Japan.
- 21) Nelson, A. R. : Congenital true esophageal diverticulum. Report of a case unassociated with other esophago-tracheal abnormality. *Ann. Surg.*, **145** : 2, 258-261, 1957.
- 22) Ogura, T. & S. Nakano : A case of bronchial diverticulum. *Kokyuki Shinryo*, **12** : 3, 200-202, 1957.
- 23) Palmer, E. D. : *The esophagus and its diseases*. 1st edition, 1952, Paul B. Hoeber, Inc., New York, U. S. A..
- 24) Postlethwait, R. W. & W. C. Sealy : *Surgery of the esophagus*. 1st edition, 1961, Charles C Thomas Publisher, Springfield, Illinois, U. S. A..
- 25) Ribbert, H. : Zur Kenntnis der Traktions-Divertikel des Oesophagus. *Virchow's Arch. f. path. Anat.*, **167** : 16-29, 1902.
- 26) Schmuck, J. A. : Zur Aetiologie des bifurkalen Oesophagusdivertikels. *Zbl. Chir.*, **87** : 16, 705-708, 1962.
- 27) Terracol, J. & R. H. Sweet : *Diseases of the esophagus*. 1st edition, 1958, W. B. Saunders Co., Philadelphia & London.
- 28) Vogt, E. C. : Congenital esophageal atresia. *Am. J. Roentgenol.*, **22** : 463-465, 1929.
- 29) Waterston, D. J., R. E. Bonham-Carter & E. Aberdeen : Congenital tracheo-oesophageal fistula in association with oesophageal atresia. *The Lancet*, 2(1963), No. 7298, 55-57, 1963.
- 30) Wheeler, D. : Diverticula of the foregut. *Radiol.*, **49** : 4, 476-482, 1947.
- 31) Winkelbauer, A. : *Chirurgie des Oesophagus*. Iter Verlag, 1955, Walter De Gruyter & Co., Berlin.
- 32) Yahr, W. Z., A. A. Azzone & T. V. Santulli : Congenital atresia of the esophagus with tracheoesophageal fistula . an unusual variant. *Surgery*, **52** : 6,937-941, 1962.
- 33) Yamasaki, M. : Ein menschlicher Embryo von 8.5mm. Scheitel-Steisslange mit fehlerhaften und ungewöhnlichen Bildungen. *Arb. a. d. anat. Inst. d. Kaiserlich-japan. Univ. zu Sendai*, Hft. **15** : 27-59, 1933.

## 和 文 抄 録

中胸部食道憩室の手術経験，とくにその  
発生病理についての再検討

京都大学医学部外科学第2講座（指導：木村忠司教授）

石 上 浩 ・ 松 尾 裕 ・ 山 根 守 ・ 鈴 木 博

従来食道憩室としては，主として咽頭食道境界部および横隔膜直上部に発生する内圧性憩室と気管分岐部に発生する牽引性憩室とが分類，記述されて来たが，われわれは最近1年半に7例の胸部，とくに中胸部食道憩室を経験し，それらの手術ならびに組織学的所見などを検討した結果，① 前腸から気管と食道とが分離・発生する際，食道閉鎖あるいは食道気管気管支瘻を生ずるまでには至らなくても，食道側に盲端に終る突出物または限局性の筋層発育の不良部位を残したり（Vogt 4型，Gross E型またはF型，あるいはH-typeの瘻孔の不全型），また② 食道の頭側分節が長く，か

つその長軸が尾側分節のそれと一致せず，その底部に囊状の突出部を残したりして（Vogt 3b型，Ladd III型あるいはGross C型の異型，または重複食道の不全型），中胸部食道憩室発生の因となりうることを確認した。とくに1例においては，憩室壁内に，前腸において食道や気管のそれらに近く原基が存在する胃や脾の組織の迷入を認めた。このような発生病理に基づくと思われる食道憩室の特徴点をわれわれの症例について吟味し，食道憩室の新しい型式として注目すべきことを強調した。